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ANALYSIS SYSTEM FOR THE DMSP SATELLITES

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An analysis system has been developed to generate and maintain quality assured data bases for the Defense Meteorological Satellite Program (DMSP) missions. This system has been adapted and maintained through a host of PL computer system changes. The generic form of the data sets has been maintained through the various system changes assuring that the large quantity of existing software and analysis packages required no modification. This approach has resulted in a cost effective means of providing continuity in the on-going analyses being performed on the geophysical parameters measured by the sensors.

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1.0 BACKGROUND

The Defense Meteorological Satellite Program (DMSP) has been in existence since the early 1960s. It has resulted in the successful launch and operation of several polar orbiting satellites designed primarily to provide tropospheric weather data through the use of the Operational Line Scan (OLS) system which has imaged the earth in both the visible light and infra-red bands. This system has been used to produce images of clouds and aurora. While the cloud images provide the necessary tropospheric data, the auroral images are an invaluable source of information on the auroral regions where increases in activity can cause serious disruptions in communications systems.

Normally there are two DMSP vehicles in operation at any given time, each with a planned lifetime in orbit of three years. They are both in sun-synchronous orbits with one operating in the dawn-dusk meridian plane (0600: to 1800:) and the other in the meridian plane covering approximately 1030: to 2230:. The altitude of these vehicles is 835-840 kilometers (circular) which results in an orbital period of approximately 101 minutes. The vehicles are non-spinning with the vehicle +X axis pointing vertically to earth throughout the orbit. Momentum wheels located within the spacecraft are used to maintain the desired attitude.

The DMSP vehicles carry secondary sensors designed for the study of the ionosphere, stratosphere, troposphere and ocean surfaces. Over the years, as the DMSP program has matured and the technology base has increased, the secondary sensors have become correspondingly more sophisticated. The early DMSP vehicles carried only one secondary experiment consisting of a simply designed sensor for the measurement of the electrons which cause the aurora.

The most recent vehicles have carried a particle spectrometer for the measurement of electron and ion fluxes; a triaxial fluxgate magnetometer; a thermal plasma monitor; and a scanning X-ray imager.

This instrumentation provides an excellent means of studying the high-latitude ionosphere which is connected to the magnetosphere. Thus, the study of magnetospheric processes can be accomplished by means of the secondary sensors flown on the DMSP vehicles. The PL Particle Spectrometer, Thermal Plasma Monitor and Fluxgate Magnetometer provide an excellent combination of experiments to monitor the polar regions.

The DMSP satellites provide an excellent source of data to perform the study of energy and information transfer between regions. Key elements of the study involve radiation belt dynamics, magnetic storm effects, and the coupling of magnetospheric energy into high latitude regions in the form of particles, fields and currents.

The data bases for the DMSP vehicles are sufficiently flexible to permit both event studies, as well as, statistical and modeling analyses. As new sensor packages, or adaptations of existing sensors, are flown, data base design was structured for consistency with the other DMSP sensors in order to maximize the use of existing analytical tools.

2.0 DMSP INSTRUMENTATION

Three instruments were used for data base development: particle spectrometers (SSJ/4); triaxial fluxgate magnetometers (SSM); and thermal plasma monitors (SSIES). A brief description of each of these instruments is included in the succeeding sections of this chapter.

2.1 SSJ/4 PARTICLE SPECTROMETER

The SSJ/4 electron and ion spectrometer has an energy range from 30 eV to 30 keV covered in 20 logarithmically spaced channels by the use of four cylindrical electrostatic analyzers (two for electrons and two for ions). Instrument apertures are mounted to look to local zenith. Electron and ion spectra are obtained approximately every second. The telemetry reads out compressed counts which when decompressed are convertible to differential number flux (and hence distribution function).

2.2 SSM TRIAXIAL FLUXGATE MAGNETOMETER

The SSM triaxial fluxgate magnetometer is mounted on the body of the DMSP vehicles and has successfully produced science quality magnetic field measurements. The sensor consists of three separate single axis fluxgate magnetometers which are mounted orthogonally on the spacecraft. The instrument obtains 20 magnetic field vector measurements per second. These vector measurements are sent to the telemetry system as compressed counts which are convertible to total magnetic field intensity. Each axis of the triaxial system has a resolution of 12 nT.

2.3 SSIES THERMAL PLASMA MONITORS

The SSIES thermal plasma experiment consists of four instruments along with associated electronics. The four instruments are the planar ion drift-meter (IDM), a planar retarding potential analyzer (RPA), a spherical electron Langmuir probe (LP) and a planar total ion density trap or scintillation meter (SM). The associated electronics includes a microprocessor used to control the instruments. The SSIES instrument measures ion and electron temperatures or scale heights, the bulk flow velocity of the thermal plasma, the plasma density and its fluctuations, ratio of light ions (H+ and He+) to 0+ and the differences between the drift velocities of the light ions and drift velocity of 0+.

The driftmeter is similar to one flown on HILAT. In its 'normal' mode, every other measurement represents the ratio of ion current flowing to the left and right halves of the sensor. The alternating measurements represent the ratio of ion current flowing to the top and bottom halves of the sensor. Unlike the HILAT driftmeter, this sensor has only one range. Thus, the ratio is converted into a flow speed of the ions in the horizontal (left to right) and vertical (top to bottom) direction by a simple trigonometric formula. This instrument has two operating modes, normal mode and H+ mode. Normal mode is intended to measure the average drift velocity of all ion species. The H+ mode, experimental in nature and, therefore, not used often, is intended to separate the measurement of the drift velocities of lighter ions, H+ and He+, from the total ion drift velocity which is dominated by O+. The instrument makes measurements of the plasma's bulk velocity and, hence, the convection electric field. The sensor measures the two components of the plasma drift velocity along two axes perpendicular to the spacecraft's velocity vector.

The scintillation meter or duct meter is similar to an RPA sensor that never retards ions. In earlier versions of this DMSP sensor, the RPA would dwell at zero voltage for 52 seconds and sweep its voltage for 12 seconds. These two modes have been made into two separate sensors. The scintillation meter now has five ranges and can change ranges at any time. The scintillation meter measures total ion density and variations in the plasma density over scale lengths from one meter to 100 km. This sensor is a simple ion trap (Faraday cup) with no retarding voltage.

The ion retarding potential analyzer data is processed to determine the temperatures, masses and densities of the different ion species present, their velocities parallel to the spacecraft's direction of motion and the spacecraft potential. The RPA measures the total flux of ions as a function of a voltage placed upon a screen within the sensor. The 'normal' mode for the RPA sensor is for that voltage to vary from a zero level to a level that repels all thermal ions in four seconds. When all ions are repelled, no current will be measured. The current collected vs voltage level data is fitted to a theoretical curve.

The electron sensor is a conducting sphere surrounded by a spherical grid. As the voltage applied to the grid changes, the sphere collects the resulting current. Data from the sensor is used to determine the electron temperature and density and the spacecraft potential. The sensor measures the total flux of electrons as a function of a voltage placed upon the sensor. The 'normal' mode for the sensor is for that voltage to vary from a level that accelerates thermal electrons to a voltage that repels all thermal electrons in four seconds. At some level, all thermal electrons will be repelled and a background current of photoelectrons and other electrons will be measured. The processing consists of finding the accelerating and repelling portions of current collected vs. voltage levels data and fitting the two regions to straight lines.

Although not an SSIES sensor, per se, the microprocessor is used to control the SSIES instrument. The microprocessor performs on-board data reduction including calculation of the plasma potential. The instrument does on-board analysis of RPA and electron sensor data. The sensor is also used to collect data similar to that going into the data stream and to calculate answers similar to the calculations to be done on the ground. Thus, the sensor calculates ion densities and temperatures and, if two ion species are present, downrange drift velocity and spacecraft potential. The processed answers in the data stream are multiplied by constants and saved for future comparisons with the answers from the ground processed answers.

3.0 DMSP ANALYSIS SYSTEM

The purpose of the DMSP analysis system was to provide each interested scientist with a readily accessible data base structured for the purpose of his follow-on studies. Such a data base was generated for each of the individual experiments, as described above.

The functional flow of data through the DMSP analysis system is described, as follows. Data from each DMSP satellite was stored first in an on-board tape recorder. Approximately once per orbit, the data was transferred to ground stations and relayed to the Air Force Global Weather Central, Offutt AFB, Nebraska. Data from the various sensors were analyzed for various operational needs. Once each day, the raw data from the ionospheric sensors were transferred to tape. The tapes were sent to PL for archiving of the data.

Each tape contained a series of files with each file having the data from a particular experiment (data from multiple spacecraft for the same experiment may have been on the same file). Each file consisted of a header record followed by multiple playbacks. Each playback contained an information record and multiple data records. All words were Univac 36 bit words; all physical records were 630, CONVEX 64 bit words in length. Several such raw data tapes, received from GWC, were concatenated onto a single tape according to a particular experiment. The header records and end of files were deleted. A copy of each concatenated tape was made to secure a backup should a tape become unreadable.

3.1 DATA BASE REFORMATTING

Since incompatibilities existed between computer systems facilities at GWC and PL, a reformatting of the raw flight tapes was required in order to put the data structure into a form which was readily accepted for further processing at the PL central computer. Also, data for a particular day overlapped files and probably overlapped tapes. The time sequence from one playback to another was random, and the order within a playback was probably in reverse chronological order. Data may have simply been missing or repeated a number of times. The reformat routines were designed to unpack the raw tape, choose data from a designated satellite, edit bad frames, account for telemetry dropout, chronologize the data from the playback passes, and create restructured files of CONVEX compatible data.

At this point, the SSM and the SSJ/4 instrument data have been separated from the other experiment data. In the case of the SSIES experiment a second phase of computer processing was required to separate the experiments out into driftmeter data, scintillation meter data, retarding potential analyzer data, Langmuir probe data, and microprocessor data.

3.2 DATA BASE INTERACTION

In general, as mass storage became available, large segments of the data base resided on the central UNITREE system at any given time. Without mass storage, the on-line portion of the data base was selectively chosen. The complete data base was subsequently archived on digital tape and CD-ROM devices. Display routines were written to allow for the viewing of calibrated and raw data at the full data rate as readout by the instruments. Interactive graphics displays consisting of averaged selected parameters in calibrated form were also produced. The logging procedure was maintained in order to allow the creation of the log file which contained information pertaining to the receipt of raw data, start and stop times, dates, and data base creation status. This log file was made accessible to the scientists so that they were aware of the status of any data base that they wished to access. The data base fed into the full rate and summary display routines as well as the routines designed to structure data bases for special studies. PL scientists thus interacted with the data base and any specially structured correlative data bases which contained data from other vehicles. Authorized scientists from outside facilities could also interact with these data bases by means of networks such as the Space Physics Analysis Network (SPAN). PL scientists could also use SPAN to 'MAIL' data sets and display files to their outside agency counterparts.

3.3 SUBROUTINE LIBRARY

One of the important features of the DMSP analysis system was the development, enhancement, and implementation of a subroutine library to perform tasks where elements of commonality existed in requirements. At the planning stages of each system upgrade or modification, the full set of requirements was reviewed and common elements were defined as items to be coded in subroutine form.

The use of this technique insured that no duplicity of code was developed. All routines utilized the library elements to assure that all common features were performed in exactly the same manner. This resulted in the development of modular routines which could easily be modified whenever requirements changed for any reason.

Examples of the types of functions which were effectively performed through the use of subroutines included: interpolations for ephemeris and magnetic parameters; implementation of calibration procedures; common display requirements; corrected geomagnetic parameter determinations; packing and unpacking procedures; spectra integration for the determination of total number flux and total energy flux; and data retrieval.

Since many of these routines were already developed for previous missions, the efficiency increased because the routines did not require development but were simply added to the DMSP subroutine library.

3.4 OVERVIEW OF DMSP PROCESSING

Data from each DMSP satellite is stored first in an onboard tape recorder. Approximately once per orbit, the data are transferred to ground stations and relayed to the Air Force Global Weather Central, Offutt AFB, Nebraska. Data from the various sensors are analyzed for various operational needs. Once each day, the raw data from the ionospheric sensors are transferred to tape. The tapes are sent to PL for archiving of the data.

The DMSP data base package has several major programs and interactive command procedure files. These interactive command procedure files generate, with input specified by the user, command procedures, or scripts, that execute a series of commands and/or programs that will be run in batch mode. Running in batch mode is necessary because of the length of time required for execution.

The first command procedure concatenates several raw data tapes, that are received from Air Force Global Weather Central (AFGWC), onto a single file. The raw data files, for a designated experiment, are found on each raw data tape and copied to an output file that is copied onto the UNITREE, an optical disk used for storing large quantities of data. The header records and end of files are deleted.

The second command procedure makes a copy of a concatenated file onto tape. This is done so that the data base tapes have a secure backup should a tape become unreadable. Also, since the raw digital data tapes are returned to AFGWC, a backup is required.

The third command procedure edits data from concatenated files. It checks for the correct satellite, valid data, and valid times. The data must fall in the user-specified day range for a specific year and month. A five day range for SSIES and a ten day range for both SSM and SSJ/4 was chosen because of the amount of temporary disk storage used to sort the data into the correct time order. Each day, identified according to experiment, satellite, year, and day, is stored on the UNITREE.

The fourth command procedure retrieves a day of data from the UNITREE and stores it onto tape. The data base tape consists of a variable number of days depending on experiment.

3.5 DMSP PROCESSING SYSTEMS

3.5.1 ACCESS AND UNPACK DATA FROM AGENCY TAPES

The DMSP data base package begins by concatenating, according to experiment, raw data from several tapes. The header records and end of files that separate one experiment from another on the agency tapes are deleted.

The concatenated tapes contain records consisting of a bit stream of Univac 36-bit words that must be appropriately unpacked according to data type and stored into 64-bit words on the CONVEX using the UNICOS operating system. These records contain data from multiple time intervals, referred to as playbacks, comprised of information records followed by data records.

3.5.2 EDIT DATA ACCORDING TO TIME CONSTRAINTS

Because the time order from one playback to another is random and the order within a playback is usually in reverse chronological order, the times are quality checked. If the time interval or the satellite identification on the information record is not what the user wants, the data for this playback is excluded.

The ephemeris times, associated with each data record, are also quality checked. If the year or day is not within the requested range or the time is less than zero or greater than 86400 seconds, the data for this record is eliminated.

If the sync value for a particular second of telemetry data is incorrect, the time for this second is set to 99999999 and the data is subsequently eliminated. An attempt is made to assign the proper day number with total seconds. Each data record is divided and stored into a file of ephemeris data and a file of telemetry data channels.

As the data on the concatenated tapes is quality checked, selected ephemeris parameters for the first, last, and every thirtieth record within an accepted playback interval are printed. For each concatenated tape processed, a printout of which playbacks have been rejected and which have been accepted is generated.

3.5.3 EDIT FILE OF TELEMETRY DATA

The file of telemetry data must be further edited. Due to digitization problems, times associated with a telemetry stream may be duplicated, missing, or incorrect.

Time values greater than or equal to 86400 may mean that the satellite clock has not been properly reset. If, after subtracting 86400 from these times, the time for a second still exceeds 86400, the data associated with this second is eliminated. If a time value is encountered that is not near its neighbors, this second of data is eliminated. If three time values that are the same are encountered, an attempt is made to shift a value into a vacant slot. If an appropriate vacant slot cannot be found, this second of data is eliminated.

A disk file consisting of day, time, and telemetry data is created. Every hundredth set of sixty consecutive day and time values is printed as this file is generated.

3.5.4 INTERPOLATE EPHEMERIS AT EVEN MINUTE

Ephemeris values are interpolated at each even minute contained within the time interval covered by the ephemeris data.

A linear interpolation is performed on the ephemeris parameters geographic latitude and longitude. The interpolation is accomplished by constructing two successive unit position vectors surrounding the time, in question, and linearly interpolating between each of the three respective components of these two vectors. The new latitude and longitude values are then derived from the components of the normalized resultant position vector.

Linear interpolation is performed on the altitude at the beginning and end of the interval in question, each of the components of the position vector in the earth centered inertial system of base vectors, and the angle on the orbital plane between the ascending node and satellite location.

3.5.5 MERGE AND PACK OUTPUT

The file of ephemeris data that has been interpolated at each even minute is merged with the file of telemetry channel data that has been edited. If there is no channel data for a particular minute, the ephemeris for this minute is deleted. For SSIES, SSIES2, and SSM a time bit map word is constructed so that, when a bit is set, data exists for a particular second following the even minute.

Examples:
77777777777777777777B (All seconds exist)
00777777777777777777B (First six seconds missing)

If data for a particular second is missing, the telemetry stream is packed continuously with zero fill at the end of existing data to ensure that the same number of words will be stored for each minute.

At each even minute corrected geomagnetic latitude and longitude at the satellite point are calculated using subroutine CGLALO90 for SSIES, SSIES2,and SSM. Using subroutines MGFLD2, LINTRA, and CONVERT geographic latitude (CLAT) and longitude (CLON) at 110km are calculated. In addition,

invariant latitude, Bx, By and Bz are calculated for SSIES, SSIES2, and SSM. Using CLAT and CLON the geomagnetic latitude and longitude at 110km are calculated using subroutine CGLALO90. The magnetic local time at 110km and for SSIES, SSIES2, and SSM the geographic latitude and longitude at the subsolar point are calculated using subroutine MAGTIM.

The ephemeris values and telemetry data are packed according to the format described in Appendix C. Thus, at the end of this level of processing a data base has been created which contains the data in chronological order with ephemeris at each even minute.

3.6 SSJ/4 DATA BASE

The telemetry for the SSJ/4 particle spectrometer consisted of compressed electron and ion values which were converted to counts and then to flux. The natural structuring for such spectrometers was to arrange the data by spectra. Electron and ion spectra structure consisted of decompressed values arranged from lowest to highest energy. Implementation of the calibration data allowed for the direct computation of spectra in terms of number flux or distribution function.

Further, spectra integration was easily performed resulting in total number flux, total energy flux and total energy. Thus, the SSJ/4 data base records consisted of Universal Time (UT), ephemeris and magnetic parameters, and the structured electron and ion spectra. The data base records were independent of calibration data, which changed over the lifetime of the flight as a result of upgraded calibrations. A data base tape was created for each half month period.

Each record on the data base file contained 2640, 16-bit words. These records contained exactly 1 minute of flight data plus 45 spare (vacant) words. Whenever less than 60 seconds of data were present on the GWC tape for any minute (due to telemetry dropout or other reasons) the missing seconds were zero filled at the end of the one minute block (i.e. following all of the existing data for the one minute interval). A 16-bit word strucure was chosen so that each pair of bytes could be swapped throughout a file. These files were copied onto tapes that were sent to an outside facility to be read on a VAX computer that expects the least significant byte in a word to be left justified.

3.7 SSM DATA BASE

Telemetry data for the SSM consisted of a series of count values representing B and delta B measurements. For each of the axes, the delta B values were first converted to B-field measurements in counts. The SSM record structure consisted of UT, ephemeris/magnetic parameters, and the triaxial B-field measurements in counts for a natural time spacing such as one second.

The retention of the B-field data in counts allowed for calibration modifications in the conversion to nT. In addition, due to the fact that the magnetometer was body-mounted, algorithms were developed to correct for anomalous outputs. The B-field data in counts was the base set of units from which the algorithms were developed.

This data base design allowed for the direct correlation of measured field data with a model magnetic field such as IGRF. The subtraction of measured from model data was used in the detection of magnetic fields induced by electric currents. A data base tape was created for each half month period.

Each record on the data base file was of fixed length and contained 3 minutes of data. For each minute there was ephemeris data and exactly 60 frames of telemetry data (one frame per second). Whenever data was missing due to telemetry dropout or other reasons, zero fill was used at the end of the good data. The use of zero fill guaranteed that all one minute groups were the same size. A 60 bit mapping word was used to indicate whether or not data existed for a particular second for the associated minute of data.

3.8 SSIES DATA BASE

The SSIES Thermal Plasma Experiment (TPE) consisted of four instruments along with a microprocessor used to control the instruments. The four instruments were the Ion Driftmeter (IDM), Retarding Potential Analyzer (RPA), Langmuir Probe (LP), and Scintillation Monitor (SM). The data for these four instruments was edited from the concatenated tapes such that only valid data at a valid time for the designated satellite was stored. The data must have fallen in the user-specified day range for a specific year and month. A data base tape was created for the first ten, middle ten, and last ten or eleven days for each month of data.

Each record on the data base file was of fixed length and contained 3 minutes of data. For each minute there was ephemeris data and exactly 60 frames of telemetry data (one frame per second). Whenever data was missing due to telemetry dropout or other reasons, zero fill was used at the end of the good data. The use of zero fill guaranteed that all one minute groups were the same size. A 60 bit mapping word was used to indicate whether or not data existed for a particular second for the associated minute of data.

3.9 CALIBRATION FILES

The calibration files used by each of the experiments were structured in ASCII. They were used directly on the central system where they were maintained, or hyper-channeled to the CONVEX. In addition to the necessary calibration data, they contained a version number and dates of applicability. In cases where a calibration set was to be completely replaced, it was removed from the system and replaced by the new file. However, the removed file was archived in the event that any questions arose at a later date.

4.0 DATA VISUALIZATION

The software package PHASEA_PC was developed to interactively display the data from the SSJ/4 experiments flown onboard the DMSP vehicles (F8, F9, F10, F11, and F12). Various tools are provided for flexible data manipulationand display to aid in the quality evaluation and interpretation of the data.

The software currently resides on NASHOBA, a Silicon Graphics Unix workstation. It was designed as a modular package, combining processing algorithms, software routines, and display capabilities developed using the full C library as well as the X11 bases windowing system. Higher level windowing and graphics tools were developed from this library of X11 primitives. Some of the modules were developed under Motif. The Motif tool kit or widget set sits on top of the Xt Intrinsic tool kit, which is part of the X window system. The software was designed to be interactive and to be accessible to PC users.

The data is archived in a one file, one day correspondence. A two pass survey of a day's data file is provided to categorize the data. The first pass is made only if the data file is less than 7,603,200 bytes, to determine the offsets for each minute available and to flag the minutes that are missing. The second pass reads and converts the fifteen word header of each minute, categorizes each minute as high or low latitude or half or full orbit, storing this data in data objects. Spectral objects representing electron and ion differential number flux are also created. The twenty channels have been reduced to 19 by combining channels 10 and 11. The energy assigned to that combined channel is that of channel 11. All spectra are formed by the same user specified parsing scheme of low latitude, high latitude, half orbit and full orbit. The averaging is a function of the parsing scheme of 2 for low/high latitude, 4 for half orbit and 8 for full orbit. The tag data sampled at 1/minute is consistent with the DMSP data summary module.

The first window introduces the user to the software. The only option to be exercised is the selection of a particular satellite. The user initially selects the DMSP satellite followed by the size of the display, either quarter screen, half screen or full screen. The following window allows the user to set all of the parameters necessary to access the appropriate data base. The only default value is the time period. It is set for an entire day, 0 - 86400 seconds. This can be adjusted by the user. All of the other parameters must be defined by the user.

If the DISPLAY option elected is SUMMARY DISPLAY, then the user will create a window of three plots of integrated data (Total Number Flux, Total Energy Flux, and Average Energy). If the SPECTOGRAM is elected from the DISPLAY category, the software will generate a spectogram of differential number flux. This data is created using X window image routines to optimize the time needed for the display. The spectogram values have been divided into fourteen bins using logarithmic values. The color scheme selected for the spectrograms is the standard GPS scheme. The data displayed will be either electron or ion depending on the selection from the ELECTRON/ION option.

The DATA DATE option offers three methods of inputting a data date. The top box expects the user to enter month, day and year while the middle box expects year and day of year. The bottom box will show the user those files that are available and the user may select from those files.

Once the selected data is displayed, the user may manipulate the data or create new displays using the following options:

- The > option will display the next data set. It may be the same time period of electron or ion data for the selected LATITUDE TYPE or it may be the next time period for the same LATITUDE TYPE, ELECTRON/ION.

- The < option will display the last data set deleted from the terminal. Note: if the user elects for the < option followed by the > option, the data displayed will be the data from the last forward motion.

- The EXPAND option allows the user to zoom in on the data. The user enters the desired x and/or y values from the keyboard. If the data at hand is a spectogram, the expanded data is displayed using an appropriate number of pixels to describe each time.

- Once the EXPAND option has been exercised, an additional button will appear, ORIGINAL. This button allows the user to replot the original display.

- NEW SATELLITE and NEW DATA allow the user to regroup and start over. Once these are chosen, all previous displays are deleted.

- DIF SPEC allows the user to select a time and view a display of differential flux. If the user is in the DATA SUMMARY mode, there will be two displays, one of electron differential flux and a second of ion differential flux. If the mode is SPECTOGRAM, only one differential flux will be displayed and it will depend in the ELECTRON/ION option selected.

- EXIT, PRINT and DELETE options are self explanatory. The PRINT of the spectogram is a grey scale print and is a spawned process.

4.1 NOSVE/CONVEX ADAPTATIONS AND MASS STORAGE DEVICES

Because the NOSVE operating system was being terminated, programs and procedures needed to be hosted on another system. In addition, the number of tape drives was being drastically reduced and the night shift eliminated. The use of tapes needed to be lessened. Executing the data base programs using

permanent files as input was a requirement so that these programs could be run without the need for computer operator participation. As regards data base interface applications, consideration was given to the mass storage devices available on various computer systems.

The CONVEX, running a UNIX operating system, was chosen because it had available a large area of scratch disk, an optical disk providing mass storage, a 64-bit integer word, and routines for byte swapping and for displaying of data to ease in the debugging of problems. Allowing the scientist to maintain a large volume of data on-line on the UNITREE storage device for his various studies facilitated analysis and graphics tasks. A 64-bit integer word allowed each UNIVAC 36-bit word to be stored in one location. Byte swapping provided the capability of creating VAX-compatible files while still generating the initial data set in bit stream format with the most significant byte left-justified.

In addition to the mass storage device hosted on the UNIX, CD-ROM disk devices provided a relatively low cost means of high capacity data storage. Such CD-ROM devices were, optionally, UNIX workstation or PC hosted. The Write Once Read Many (WORM) times feature of these disks allowed them to be used for archiving large data sets in a compact form, for transferring volumes of data between machines and facilities in an efficient manner, and providing a flexibility of use for the scientist who used large data sets of DMSP data.

APPENDIX A - VEHICLES/EXPERIMENTS/PERIODS PROCESSED

Vehicle	Experiment	Period Processed
F8	SSJ/4	June 25 of 1987 through August 1 of 1994
	SSIES	"
F9	SSJ/4	February 8 of 1988 through April 4 of 1992
	SSIES	"
F10	SSJ/4	Dec 7-8 of 1990, Dec 19 of 1990 through Sept 26 of 1994, and Oct 3 of 1994 through Apr 20 of 1995
	SSIES	Dec 7-8 of 1990 and Dec 19 of 1990 through Sept 26 of 1994
F11	SSJ/4	December 3 1991 through April 20 of 1995
	SSIES2	"
F12	SSJ/4	August 29 of 1994 through Sept 26 of 1994, Nov 29-30 1994 and Dec 16 1994 through Apr 20 of 1995
	SSIES2	August 29 of 1994 through Apr 20 of 1995
	SSM	"
F13	SSJ/4	March 29 1995 through April 20 1995
	SSIES2	"
	SSM	"

APPENDIX B - AGENCY TAPE FORMAT

Data tapes are produced at AFGWC, Omaha, Nebraska.

Each tape contains a series of files with each file having the data from a particular experiment (data from multiple spacecraft for the same experiment may be on the same file). Each file consists of a header record followed by multiple playbacks. Each playback contains an information record and multiple data records. The formats for these record types follow. All words are Univac 36-bit words; all physical records are 1120, 36-bit words in length. In general, data for a particular day will overlap files and probably overlap tapes. The time order from one playback to another is random, and the order within a playback is probably in reverse chronological order. Data may simply be missing or repeated a number of times.

Header Record:
The header record contains 20 Univac 36-bit words of information for the first playback followed by eight zero filled words. The succeeding 28 words contain information for the second playback, etc.. These words are followed by zero filled words to bring the record to the specified length. The word definitions are as follows:

Word No.	Bits	Description
1	1-36	Processing batch number (I)
2	1-36	Satellite ID (eg. WX9543) (A)
3	1-36	Playback rev number (I)
4	1-36	Nodal longitude x 10 (I)
5	1-36	Nodal Julian hour (I)
6	1-6	Nodal day (I)
	7-12	Nodal month (I)
	13-24	Nodal year (I)
	25-36	Nodal time - HHMM (eg. 2359) (I)
7	1-36	Beginning address (I)
8	1-36	Ending address + 1 (I)
9	1-36	Number of logical data records in playback (I)
10	1-12	Julian day of first record in playback (I)
	13-18	Filler
	19-24	Hour of first playback (I)
	25-30	Minute of first playback (I)
	31-36	Second of first playback (I)
11	1-12	Julian day of last playback (I)
	13-18	Filler
	19-24	Hour of last playback (I)
	25-30	Minute of last playback (I)
	31-36	Second of last playback (I)
12	1-36	Number of physical records in playback (I)
13	1-36	Number of playbacks (I)
14	1-36	Namel (A)
15	1-36	Namem Identifying (A)
16	1-36	Namer Experiment (A)
17	1-36	Playback rev number (I)
18	1-36	Frame count (I)
19	1-36	Number of time code discontinuities (I)
20	1-36	Tape physical record size (e.g.1120 words)(I)
21-28		Zero filled
29-56		Words 1-28 repeated for the next playback
57-84		" " " " " " "

Information for each playback within this file is stored in this header record. After the last word of information the remaining words are zero filled to bring the record to the specified length of 1120, 36-bit words.

Information Record:

The information record for each playback contains the same twenty-eight words as in the header record for that playback. The remaining words are zero filled to bring the record to the specified length.

Data Records:

Following the information record are the data records for this playback. Each data record has the ephemeris data for a one minute period followed by the telemetry data in 60 one second intervals, consisting of a sync word, time word, and telemetry data.

Ephemeris Data: All words are 36-bit Univac words.

Word No	Description
1	Lat1 geodetic - radians (R)
2	Long1 - radians (R)
3	Alt1 - NM (I)
4	Julian day1 (I)
5	Time1 - Time of first readout on record-seconds (I)
6	Lat2 - As above for 60 seconds earlier (R)
7	Long2 - As above for 60 seconds earlier (R)
8	Alt2 - As above for 60 seconds earlier (I)
9	Julian day2 - As above for 60 seconds earlier (I)
10	Time2 - As above for 60 seconds earlier (I)
11	X1 Position (R)
12	Y1 Position (R)
13	Z1 Position (R)
14	X2 Position for 60 seconds earlier (R)
15	Y2 Position for 60 seconds earlier (R)
16	Z2 Position for 60 seconds earlier (R)
17	Lat1A x 10000 - Geodetic - radians (I)
18	Long1A x 10000 - radians (I)
19	Alt1A - NM (R)
20	Lat2A - As above for 60 seconds earlier (I)
21	Long2A - As above for 60 seconds earlier (I)
22	Alt2A - As above for 60 seconds earlier (R)
23	Sath angle 1 (R)
24	Sath angle 2 (R)
25	Dummy (I)
26	Dummy (I)
27	Dummy (I)
28	Dummy (I)
29-1120	Sixty sets of sync, time, and telemetry follow. (I) The time is in bits 10-36 of the second word. (Seconds is obtained by dividing the integer value by 1024.)

SSIES Experiment:
For the SSIES experiment, there are a total of 120, 9-bit words per second. Thus, data records require 28 + 60(30 + 2) = 1948 Univac words per minute. With a block size of 1120 words, GWC will require one physical record plus a portion of another record to store one minute of data. The first record will have a

full 1120 word record of flight data; the second record will have 828 data words followed by 68 zero filled words. The second logical record begins at word 897 of the second physical record. Refer to Figure 1.

SSIES2 Experiment:
For the SSIES2 experiment, there are a total of 84, 9-bit words per second. Thus, data records require 28 + 60(21 + 2) = 1408 Univac words per minute, followed by 48 zero filled words. GWC required one physical record plus a portion of another record to store one minute of data. Refer to Figure 2.

SSJ/4 Experiment:
For the SSJ/4 experiment, there are a total of 40, 9-bit words per second. Thus, data records require 28 + 60(10 + 2) = 748 Univac words per minute, followed by 36 zero filled words. GWC required less than one physical record to store one minute of data. Refer to Figure 3.

SSM Experiment:
For the SSM experiment, there are a total of 28, 9-bit words per second. Thus, data records require 28 + 60(7 + 2) = 568 Univac words per minute, followed by 104 zero filled words. GWC required less than one physical record to store one minute of data. Refer to Figure 4.

Figure 1 - SSIES Logical/Physical Record Structure

R.N. 1	2	3	4	5	6	7	8	9	10
1120 words*	828 + 68 words ----- 224 words	1120 words	604 + 68 words ----- 448 words	1120 words	380 + 68 words ----- 672 words	1120 words	156 + 68 words ----- 896 words	1052 + 68 words	1120 words

* All words are 36-bit words.

R.N. = Physical record number.

Logical record no. 1 consists of 1120 words plus 828 words plus 68 zero filled words.

Logical record no. 2 consists of 224 words plus 1120 words plus 604 words plus 68 words. (etc.)

Logical record no. 5 ends evenly on the ninth record.

The sequence is repeated beginning at physical record no. 10.

Figure 2 - SSIES2 Logical/Physical Record Structure

RN	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	1120 wrds*	288 + 48 wds --- 784 wds	624 + 48 wds --- 448 wds	960 + 48 wds --- 112 wds	1120 wrds	176 + 48 wds --- 896 wds	512 + 48 wds --- 560 wds	848 + 48 wds --- 224 wds	1120 wrds	64 + 48 wrds ---- 1008 wrds	440 + 48 wds --- 672 wds	736 + 48 wds --- 336 wds	1072 + 48 wrds	1120 wrds

* All words are 36-bit words.

R.N. = Physical record number.

Logical record no. 1 consists of 1120 words plus 288 words plus 48 zero filled words.

Logical record no. 10 ends evenly on physical record no. 13.

The sequence is repeated beginning at physical record no. 14.

Figure 3 - SSJ/4 Logical/Physical Record Structure

R.N. 1	2	3	4	5	6	7
748 + 36 words*	412 + 36 words	76 + 36 words	524 + 36 words	188 + 36 words	636 + 36 words	300 + 36 words
336 words	672 words	748 + 36 words	560 words	748 + 36 words	448 words	748 + 36 words
		224 words		112 words		

* All words are 36-bit words.

R.N. = Physical record number.

All logical records contain 748 words + 36 zero fill words.

Logical record no. 1 consists of 748 words plus 36 zero filled words.

Logical record no. 2 consists of 336 words from physical record no. 1 plus 412 words and 36 zero fill words from physical record no. 2.

Logical record no. 10 ends evenly with physical record no. 7.

The sequence is repeated beginning at physical record no. 8.

Figure 4 - SSM Logical/Physical Record Structure

```
R.N. 1    2     3
------  -----  -----
|      | 120 |      |
|      |  +  | 334  |
| 568  | 104 |  +   |
|  +   |words| 104  |
| 104  |-----|words |
|words*|     |      |
|      | 568 |----- |
|      |  +  |      |
|------| 104 | 568  |
|      |words|  +   |
| 448  |     | 104  |
|words |-----|words |
|      | 224 |      |
|      |words|      |
  ------ ----- -----
* All words are 36-bit words.
```

R.N. = Physical record number.

All logical records contain 568 words + 104 zero fill words.

Logical record no. 1 consists of 568 words plus 104 zero filled words.

Logical record no. 2 consists of 448 words from physical record no. 1 plus 120 words plus 104 words from physical record no. 2.

Logical record number 5 ends evenly with physical record number 3.
The sequence is repeated beginning at physical record no. 4.

APPENDIX C - EXPERIMENT DATA BASE FORMATS

SSIES DATA BASE FORMAT (F8 - F10)

There are 3060 words (64 bits/word) per physical record. Each record contains 3 minutes of data. For each minute there is ephemeris data and exactly 60 frames of telemetry data (one frame per second). Each minute of data requires 1019.0625 words. The three minutes of data are stored in bytes 1-24458/4. Bytes 24458/4 - 24465 contain a code word to identify the spacecraft. The remaining 16 bytes are vacant (zero fill). The last record of data for a day is followed by an End of File. If the last record for a day does not contain three minutes of SSIES data, the day number following the last good set of data is set to 999 and the remainder of the record is zero filled.

Should data be missing due to telemetry dropout or other reasons, zero fill is used at the end of the good data. The use of zero fill guarantees that all one minute groups are the same size. A 60-bit mapping word is used to indicate whether or not data exists for a particular second for the associated minute of data. If bit 60 is set to 1, the data for the zero second exists; if bit 59 is set to 1, the data for the next second exists, etc..

All angles are in degrees and the altitude is in nautical miles. In the bit numbering sequence below, bit 8 is the most significant bit of a byte and bit 1 is the least significant bit.

Byte/Bit	-	Byte/Bit	# of Bits	Description
1/8	-	2/5	12	Geographic longitude(GLON)[X10]
2/4	-	3/1	12	Geographic latitude(GLAT)[X10]
4/8	-	4/3	6	Second(IS)
4/2	-	5/5	6	Minute(IM)
5/4	-	6/7	6	Hour(IH)
6/6	-	7/3	12	Day of year (JDAY)
7/2	-	8/5	6	Year (IYR) [Year=IYR+1950]
8/4	-	9/1	12	Geomagnetic latitude at 110 km (RMLAT)[X10]
10/8	-	11/5	12	Geomagnetic longitude at satellite (GMLONST)[X10]
11/4	-	12/1	12	Geomagnetic latitude at satellite (GMLATST)[X10]
13/8	-	14/5	12	Geographic longitude at subsolar point (ALON)[X10]
14/4	-	15/1	12	Geographic latitude at subsolar point (DEC)[X10]
16/8	-	17/5	12	Alt. at beginning of ephem. minute (ALTBEG)-N.Mi.
17/4	-	18/1	12	Invariant latitude (RNVARLT)[X10]
19/8	-	20/5	12	Geographic longitude of magnetic field line traced from the spacecraft to 110 km (CLON)[X10]
20/4	-	21/1	12	Geographic latitude of magnetic field line traced from the spacecraft to 110 km
22/8	-	23/5	12	Geomagnetic longitude of magnetic field line traced from the spacecraft to 110 km (RMLON)[X10]
23/4	-	25/1	20	X coordinate of satellite in ECI (XECOS)[X10**5]
26/8	-	28/7	18	Magnetic local time of magnetic field line traced from the spacecraft to 110 km

			(RMLT)-SEC
28/6	- 29/3	12	Alt. at end of ephemeris minute (ALTEND) - N.Mi.
29/2	- 30/1	10	Filler
31/8	- 33/5	20	BX in 10ths of gamma
33/4	- 35/1	20	Z coordinate of satellite in ECI (ZECOS)[X10**5]
36/8	- 38/5	20	Y coordinate of satellite in ECI (YECOS)[X10**5]
38/4	- 40/1	20	BZ in 10ths of gamma
41/8	- 43/5	20	BY in 10ths of gamma
43/4	- 45/1	20	FILLER
46/8	- 53/5	60	Mapping Word (IMAP)
53/4	- 8153/5	64800	60 groups of: 30, 36-bit words (one group per sec)
8153/4	-16305/1		Repeat order of bytes 1-8153/5 for the next minute
16306/1	-24458/5		Repeat order of bytes 1-8153/5 for the next minute
24458/4	-24465/1	60	Satellite id (integer; 8 = F8)
24466/8	-24480/1	120	Vacant (zero fill)

NOTES:

1. The 30 36-bit words containing the telemetry data actually consist of 120 9-bit words (since the SSIES telemetry rate is 1080 bps).
2. For XECOS, YECOS and ZECOS, if the MSB of the 20-bit word is set to 1, the value is negative. To obtain the proper negative number subtract 1048575 from the value stored in the 20 bits.
3. For BX, BY and BZ, if the MSB of the 20-bit word is set to 1, the value is negative. Use the same procedure described in 2. above to get the proper value.
4. For all latitude values, if the MSB of the 12-bit word is set to 1, the number is negative. To obtain the proper negative number, subtract 4095 from the value stored in the 12-bit word.

SSIES-2 DATA BASE FORMAT (F11 - F13)

There are 2385 words (64 bits/word) per physical record.

Each record contains 3 minutes of data. For each minute there is ephemeris data and exactly 60 frames of telemetry data (one frame per second). Each minute of data requires 794.0625 words (64-bits/word). The three minutes of data are stored in bytes 1-19058/5. Bytes 19058/4 - 19065 contain a code word to identify the spacecraft. The remaining 7 bytes indicate the magnetic field model used. The last record of data for a day is followed by an End of File. If the last record for a day does not contain three minutes of SSIES-2 data, the day number following the last good set of data is set to 999 and the remainder of the record is zero filled.

Should data be missing due to telemetry dropout or other reasons, zero fill is used at the end of the good data. The use of zero fill guarantees that all one minute groups are the same size. A 60-bit mapping word is used to indicate whether or not data exists for a particular second for the associated minute of data. If bit 60 is set to 1, the data for the zero second exists; if bit 59 is set to 1, the data for the next second exists, etc..
All angles are in degrees and the altitude is in nautical miles. In the bit numbering sequence below, bit 8 is the most significant bit of a byte and bit 1 is the least significant bit.

Byte/Bit	-	Byte/Bit	# of Bits	Description
1/8	-	2/5	12	Geographic longitude(GLON)[X10]
2/4	-	3/1	12	Geographic latitude(GLAT)[X10]
4/8	-	4/3	6	Second(IS)
4/2	-	5/5	6	Minute(IM)
5/4	-	6/7	6	Hour(IH)
6/6	-	7/3	12	Day of year (JDAY)
7/2	-	8/5	6	Year (IYR) [Year=IYR+1950]
8/4	-	9/1	12	Geomagnetic latitude at 110 km (RMLAT)[X10]
10/8	-	11/5	12	Geomagnetic longitude at satellite (GMLONST)[X10]
11/4	-	12/1	12	Geomagnetic latitude at satellite (GMLATST)[X10]
13/8	-	14/5	12	Geographic longitude at subsolar point (ALON)[X10]
14/4	-	15/1	12	Geographic latitude at subsolar point (DEC)[X10]
16/8	-	17/5	12	Alt. at beginning of ephem. minute (ALTBEG)-N.Mi.
17/4	-	18/1	12	Invariant latitude (RNVARLT)[X10]
19/8	-	20/5	12	Geographic longitude of magnetic field line traced from the spacecraft to 110 km (CLON)[X10]
20/4	-	21/1	12	Geographic latitude of magnetic field line traced from the spacecraft to 110 km (CLAT)[X10]
22/8	-	23/5	12	Geomagnetic longitude of magnetic field line traced from the spacecraft to 110 km (RMLON)[X10]
23/4	-	25/1	20	X coordinate of satellite in ECI (XECOS)[X10**5]
26/8	-	28/7	18	Magnetic local time of magnetic field line traced from the spacecraft to 110 km (RMLT)-SEC
28/6	-	29/3	12	Alt. at end of ephemeris minute (ALTEND) - N.Mi.
29/2	-	30/1	10	Filler
31/8	-	33/5	20	BX in 10ths of gamma

33/4	- 35/1	20	Z coordinate of satellite in ECI (ZECOS)[X10**5]
36/8	- 38/5	20	Y coordinate of satellite in ECI (YECOS)[X10**5]
38/4	- 40/1	20	BZ in 10ths of gamma
41/8	- 43/5	20	BY in 10ths of gamma
43/4	- 45/1	20	Sath Angle [X10**5]
46/8	- 53/5	60	Mapping Word (IMAP)
53/4	- 6353/5	50400	60 groups of: 22, 36-bit words + 48 zero bits (one group per sec)
6353/4	-12705/1		Repeat order of bytes 1-6353/5 for the next minute
12706/8	-19058/5		Repeat order of bytes 1-6353/5 for the next minute
19058/4	-19065/1	60	Satellite id
19066/8	-19072/1	56	Magnetic Field Model used
19073/8	-19080/1	64	Vacant

NOTES:

1. The 22 36-bit words containing the telemetry data actually consist of time (36 bits) and 84 9-bit data words. Each time word should be divided by 1024 to get the time in seconds.
2. For XECOS, YECOS and ZECOS, if the MSB of the 20-bit word is set to 1, the value is negative. To obtain the proper negative number subtract 1048575 from the value stored in the 20 bits.
3. For BX, BY and BZ, if the MSB of the 20-bit word is set to 1, the value is negative. Use the same procedure described in 2. above to get the proper value.
4. For all latitude values, if the MSB of the 12-bit word is set to 1, the number is negative. To obtain the proper negative number, subtract 4095 from the value stored in the 12-bit word.
5. For the Magnetic Field model indicator (19066/8 - 19072/1), character string information has been converted into a set of 8 bit bytes with each byte representing one ASCII character.

SSM DATA BASE FORMAT (F12/F13)

There are 6680 bytes per physical record. Each record contains 3 minutes of data. For each minute there is ephemeris data and exactly 60 frames of telemetry data (one frame per second). Each minute of data requires 2220 bytes. The three minutes of data are stored in bytes 1-6660. Bytes 6661 - 6668 contain a code word to identify the spacecraft. Bytes 6669 - 6675 are used to indicate the magnetic field model used. The last record of data for a day is followed by an End of File. If the last record for a day does not contain three minutes of SSM data, the day number following the last good set of data is set to 999 and the remainder of the record is zero filled.

Should data be missing due to telemetry dropout or other reasons, zero fill is used at the end of the good data. The use of zero fill guarantees that all one minute groups are the same size. A 60-bit mapping word is used to indicate whether or not data exists for a particular second for the associated minute of data. If bit 60 is set to 1, the data for the zero second exists; if bit 59 is set to 1, the data for the next second exists, etc..

All angles are in degrees and the altitude is in nautical miles. In the bit numbering sequence below, bit 8 is the most significant bit of a byte and bit 1 is the least significant bit.

Byte/Bit	-	Byte/Bit	# of Bits	Description
1/8	-	2/5	12	Geographic longitude(GLON)[X10]
2/4	-	3/1	12	Geographic latitude(GLAT)[X10]
4/8	-	4/3	6	Second(IS)
4/2	-	5/5	6	Minute(IM)
5/4	-	6/7	6	Hour(IH)
6/6	-	7/3	12	Day of year (JDAY)
7/2	-	8/5	6	Year (IYR) [Year=IYR+1950]
8/4	-	9/1	12	Geomagnetic latitude at 110 km (RMLAT)[X10]
10/8	-	11/5	12	Geomagnetic longitude at satellite (GMLONST)[X10]
11/4	-	12/1	12	Geomagnetic latitude at satellite (GMLATST)[X10]
13/8	-	14/5	12	Geographic longitude at subsolar point (ALON)[X10]
14/4	-	15/1	12	Geographic latitude at subsolar point (DEC)[X10]
16/8	-	17/5	12	Alt. at beginning of ephem. minute (ALTBEG)-N.Mi.
17/4	-	18/1	12	Invariant latitude (RNVARLT)[X10]
19/8	-	20/5	12	Geographic longitude of magnetic field line traced from the spacecraft to 110 km (CLON)[X10]
20/4	-	21/1	12	Geographic latitude of magnetic field line traced from the spacecraft to 110 km (CLAT)[X10]
22/8	-	23/5	12	Geomagnetic longitude of magnetic field line traced from the spacecraft to 110 km (RMLON)[X10]
23/4	-	25/1	20	X coordinate of satellite in ECI (XECOS)[X10**5]
26/8	-	28/7	18	Magnetic local time of magnetic field line traced from the spacecraft to 110 km (RMLT)-SEC
28/6	-	29/3	12	Alt. at end of ephemeris minute (ALTEND) - N.Mi.
29/2	-	30/1	10	Filler
31/8	-	33/5	20	BX in 10ths of gamma

33/4	-	35/1	20	Z coordinate of satellite in ECI (ZECOS)[X10**5]
36/8	-	38/5	20	Y coordinate of satellite in ECI (YECOS)[X10**5]
38/4	-	40/1	20	BZ in 10ths of gamma
41/8	-	43/5	20	BY in 10ths of gamma
43/4	-	45/1	20	Filler
46/8	-	53/5	60	Mapping Word (IMAP)
53/4	-	60/1	60	Filler
61	-	2220	17280	60 groups of 8 36-bit words (one per sec)
2221	-	4440		Repeat order of bytes 1-2220 for next minute
4441	-	6660		Repeat order of bytes 1-2220 for next minute
6661/8	-	6668/1		Satellite id (integer; 12 = F12)
6669/8	-	6675/1		Magnetic Field Model used
6676	-	6680		Vacant

NOTES:

1. The 8 36-bit words containing the telemetry data actually consist of time (36 bits) and 28 9-bit data words. Each time word should be divided by 1024 to get the time in seconds.
2. For XECOS, YECOS and ZECOS, if the MSB of the 20-bit word is set to 1, the value is negative. To obtain the proper negative number subtract 1048575 from the value stored in the 20 bits.
3. For BX, BY and BZ, if the MSB of the 20-bit word is set to 1, the value is negative. Use the same procedure described in 2. above to get the proper value.
4. For all latitude values, if the MSB of the 12-bit word is set to 1, the number is negative. To obtain the proper negative number, subtract 4095 from the value stored in the 12-bit word.
5. For the Magnetic Field model indicator (6669/8 - 6675/1), a character string has been converted into a set of 8 bit bytes with each byte representing one ASCII character (e.g. 'IGRF85').

SSJ/4 DATA BASE FORMAT (F8 - F13)

TAPE BLOCKING STRUCTURE: There are 2640 (16 bit) words per record. The data is binary, unsigned and right justified.

Each record contains one minute of flight data. Missing seconds of data (due to telemetry dropout or other reasons) are zero filled at the end of the one minute block (i.e. following all of the normal data for the one minute interval). The last 45 words of every record are vacant (zero fill). The last record of data for a day is followed by an End of File.

Each record consists of 15 time and ephemeris words followed by 60 groups of time and associated spectra of telemetry readouts from the J/4 detector. Within each spectra of telemetry readouts, there will be 20 (9 bit) electron values followed by 20 (9 bit) ion values. Each 9 bit value will be stored (right justified) in a 16 bit word.

DATA BASE RECORD FORMAT:

Word	Description	Definition
1	JDAY	Day of year
2	IHR	Hour of day
3	IMIN	Minute of hour
4	ISEC	Second of minute
5	IYR(YR-50)	Year-50 (e.g. 84=34)
6	GLAT[X10]+900	Geographic Latitude
7	GLON[X10]	Geographic Longitude
8	IALT	Altitude (NM)
9	CLAT[X10]+900	CGM 110 km geog lat
10	CLONG[X10]	CGM 110 km geog long
11	RMLAT[X10]+900	Mag. latitude
12	RMLONG[X10]	Mag. longitude
13	MLTHR	Hour of mag. local time
14	MLTMIN	Minute of mag. local time
15	MLSEC	Second of mag. local time
16	IHR	Hour of day (first spectra)
17	IMIN	Minute of hour "
18	ISEC	Second of minute "
19	E4	Channel E4 (9LSBS)
20	E3	E3
21	E2	E2
22	E1	E1
23	E8	E8
24	E7	E7
25	E6	E6
26	E5	E5
27	E12	E12
28	E11	E11
29	E10	E10
30	E9	E9
31	E16	E16
32	E15	E15
33	E14	E14
34	E13	E13
35	E20	E20
36	E19	E19
37	E18	E18
38	E17	E17

39-58	Ion spectra (word order same as electrons).
59-101	Repeat order of words 16-58 for next spectra.
102-144	Repeat order of words 16-58 for next spectra.
.	.
.	.
.	.
2553-2595	Repeat order of words 16-58 for last spectra in one minute group of 60 spectra.
2596-2640	Vacant (zero fill).

APPENDIX D - CALIBRATION TABLES

SSJ/4 F8 ELECTRONS - CONVERSION CONSTANTS

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX
1	31.300	3.260E-04	3.130E+04	1.603E-34	9.993E+06
2	21.100	2.750E-04	3.711E+04	2.819E-34	6.655E+06
3	14.300	2.300E-04	4.437E+04	4.973E-34	3.610E+06
4	9.720	1.850E-04	5.516E+04	9.096E-34	2.061E+06
5	6.610	1.520E-04	6.713E+04	1.628E-33	1.158E+06
6	4.500	1.180E-04	8.648E+04	3.080E-33	6.927E+05
7	3.050	8.990E-05	1.135E+05	5.966E-33	4.206E+05
8	2.070	7.300E-05	1.398E+05	1.082E-32	2.387E+05
9	1.400	5.390E-05	1.893E+05	2.168E-32	1.484E+05
10	0.950	4.270E-05	2.390E+05	4.032E-32	8.627E+04
11	0.950	3.200E-05	3.189E+05	5.381E-32	1.151E+05
12	0.640	2.430E-05	4.199E+05	1.052E-31	6.853E+04
13	0.440	1.940E-05	5.260E+05	1.916E-31	3.819E+04
14	0.310	1.260E-05	8.098E+05	4.188E-31	2.887E+04
15	0.210	8.840E-06	1.154E+06	8.811E-31	2.012E+04
16	0.144	5.630E-06	1.812E+06	2.018E-30	1.462E+04
17	0.098	3.300E-06	3.092E+06	5.058E-30	1.152E+04
18	0.068	1.940E-06	5.260E+06	1.240E-29	9.478E+03
19	0.045	1.070E-06	9.537E+06	3.397E-29	7.939E+03
20	0.031	5.530E-07	1.845E+07	9.542E-29	8.008E+03

CH	ENERGY	C-NFLX	C-EDENS	C-NDENS
1	31.300	3.193E+05	1.195E-02	3.819E-04
2	21.100	3.154E+05	9.697E-03	4.596E-04
3	14.300	2.524E+05	6.389E-03	4.468E-04
4	9.720	2.121E+05	4.425E-03	4.553E-04
5	6.610	1.752E+05	3.015E-03	4.561E-04
6	4.500	1.539E+05	2.185E-03	4.857E-04
7	3.050	1.379E+05	1.612E-03	5.285E-04
8	2.070	1.153E+05	1.110E-03	5.365E-04
9	1.400	1.060E+05	8.396E-04	5.997E-04
10	0.950	9.081E+04	5.924E-04	6.236E-04
11	0.950	1.212E+05	7.905E-04	8.321E-04
12	0.640	1.071E+05	5.733E-04	8.959E-04
13	0.440	8.679E+04	3.853E-04	8.757E-04
14	0.310	9.313E+04	3.471E-04	1.120E-03
15	0.210	9.581E+04	2.939E-04	1.399E-03
16	0.144	1.015E+05	2.578E-04	1.790E-03
17	0.098	1.175E+05	2.462E-04	2.512E-03
18	0.068	1.394E+05	2.433E-04	3.578E-03
19	0.045	1.764E+05	2.505E-04	5.566E-03
20	0.031	2.583E+05	3.044E-04	9.820E-03

SSJ/4 F8 IONS - CONVERSION CONSTANTS

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX
1	31.300	1.150E-03	8.873E+03	1.531E-28	2.833E+06
2	21.100	7.690E-04	1.327E+04	3.395E-28	2.380E+06
3	14.300	5.290E-04	1.929E+04	7.283E-28	1.570E+06
4	9.720	3.610E-04	2.827E+04	1.570E-27	1.056E+06
5	6.610	2.500E-04	4.082E+04	3.334E-27	7.042E+05
6	4.500	1.680E-04	6.074E+04	7.287E-27	4.865E+05
7	3.050	1.150E-04	8.873E+04	1.571E-26	3.288E+05
8	2.070	8.170E-05	1.249E+05	3.258E-26	2.133E+05
9	1.400	5.290E-05	1.929E+05	7.439E-26	1.512E+05
10	0.950	3.650E-05	2.796E+05	1.589E-25	1.009E+05
11	0.950	1.110E-03	9.193E+03	5.224E-27	3.319E+03
12	0.640	7.410E-04	1.377E+04	1.162E-26	2.247E+03
13	0.440	5.190E-04	1.966E+04	2.412E-26	1.427E+03
14	0.310	3.490E-04	2.924E+04	5.092E-26	1.042E+03
15	0.210	2.430E-04	4.199E+04	1.080E-25	7.319E+02
16	0.144	1.640E-04	6.222E+04	2.333E-25	5.017E+02
17	0.098	1.110E-04	9.193E+04	5.065E-25	3.423E+02
18	0.068	7.940E-05	1.285E+05	1.020E-24	2.316E+02
19	0.045	5.290E-05	1.929E+05	2.314E-24	1.606E+02
20	0.031	3.700E-05	2.758E+05	4.803E-24	1.197E+02

CH	ENERGY	C-NFLX	C-EDENS	C-NDENS
1	31.300	9.051E+04	1.451E-01	4.635E-03
2	21.100	1.128E+05	1.484E-01	7.035E-03
3	14.300	1.098E+05	1.189E-01	8.315E-03
4	9.720	1.087E+05	9.708E-02	9.987E-03
5	6.610	1.065E+05	7.847E-02	1.187E-02
6	4.500	1.081E+05	6.571E-02	1.460E-02
7	3.050	1.078E+05	5.394E-02	1.769E-02
8	2.070	1.030E+05	4.247E-02	2.052E-02
9	1.400	1.080E+05	3.662E-02	2.616E-02
10	0.950	1.062E+05	2.967E-02	3.123E-02
11	0.950	3.493E+03	9.755E-04	1.027E-03
12	0.640	3.512E+03	8.048E-04	1.258E-03
13	0.440	3.244E+03	6.165E-04	1.401E-03
14	0.310	3.362E+03	5.364E-04	1.730E-03
15	0.210	3.485E+03	4.576E-04	2.179E-03
16	0.144	3.484E+03	3.788E-04	2.631E-03
17	0.098	3.493E+03	3.133E-04	3.197E-03
18	0.068	3.406E+03	2.544E-04	3.742E-03
19	0.045	3.569E+03	2.169E-04	4.820E-03
20	0.031	3.861E+03	1.948E-04	6.283E-03

SSJ/4 F9 ELECTRONS - CONVERSION CONSTANTS

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX
1	31.300	2.010E-04	5.077E+04	2.600E-34	1.621E+07
2	21.100	1.700E-04	6.002E+04	4.560E-34	1.077E+07
3	14.300	1.420E-04	7.186E+04	8.055E-34	5.847E+06
4	9.720	1.150E-04	8.873E+04	1.463E-33	3.316E+06
5	6.610	9.370E-05	1.089E+05	2.641E-33	1.879E+06
6	4.500	7.290E-05	1.400E+05	4.986E-33	1.121E+06
7	3.050	5.550E-05	1.839E+05	9.663E-33	6.813E+05
8	2.070	4.510E-05	2.263E+05	1.752E-32	3.864E+05
9	1.400	3.330E-05	3.064E+05	3.509E-32	2.402E+05
10	0.950	2.640E-05	3.865E+05	6.522E-32	1.395E+05
11	0.950	3.930E-05	2.596E+05	4.381E-32	9.373E+04
12	0.640	2.980E-05	3.424E+05	8.577E-32	5.588E+04
13	0.440	2.380E-05	4.287E+05	1.562E-31	3.113E+04
14	0.310	1.550E-05	6.583E+05	3.404E-31	2.347E+04
15	0.210	1.080E-05	9.448E+05	7.212E-31	1.647E+04
16	0.144	6.900E-06	1.479E+06	1.646E-30	1.193E+04
17	0.098	4.050E-06	2.520E+06	4.121E-30	9.383E+03
18	0.068	2.380E-06	4.287E+06	1.011E-29	7.726E+03
19	0.045	1.310E-06	7.789E+06	2.775E-29	6.485E+03
20	0.031	6.780E-07	1.505E+07	7.782E-29	6.532E+03

CH	ENERGY	C-NFLX	C-EDENS	C-NDENS
1	31.300	5.178E+05	1.939E-02	6.195E-04
2	21.100	5.102E+05	1.569E-02	7.434E-04
3	14.300	4.089E+05	1.035E-02	7.237E-04
4	9.720	3.412E+05	7.119E-03	7.324E-04
5	6.610	2.842E+05	4.891E-03	7.399E-04
6	4.500	2.492E+05	3.537E-03	7.861E-04
7	3.050	2.234E+05	2.611E-03	8.561E-04
8	2.070	1.867E+05	1.797E-03	8.683E-04
9	1.400	1.716E+05	1.359E-03	9.707E-04
10	0.950	1.469E+05	9.582E-04	1.009E-03
11	0.950	9.867E+04	6.436E-04	6.775E-04
12	0.640	8.732E+04	4.675E-04	7.305E-04
13	0.440	7.074E+04	3.141E-04	7.138E-04
14	0.310	7.571E+04	2.821E-04	9.101E-04
15	0.210	7.842E+04	2.405E-04	1.145E-03
16	0.144	8.282E+04	2.103E-04	1.461E-03
17	0.098	9.574E+04	2.006E-04	2.047E-03
18	0.068	1.136E+05	1.983E-04	2.916E-03
19	0.045	1.441E+05	2.046E-04	4.547E-03
20	0.031	2.107E+05	2.483E-04	8.010E-03

SSJ/4 F9 IONS - CONVERSION CONSTANTS

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX
1	31.300	1.140E-03	8.951E+03	1.544E-28	2.858E+06
2	21.100	7.620E-04	1.339E+04	3.426E-28	2.402E+06
3	14.300	5.240E-04	1.947E+04	7.352E-28	1.584E+06
4	9.720	3.570E-04	2.858E+04	1.588E-27	1.068E+06
5	6.610	2.480E-04	4.115E+04	3.361E-27	7.098E+05
6	4.500	1.670E-04	6.110E+04	7.331E-27	4.894E+05
7	3.050	1.140E-04	8.951E+04	1.584E-26	3.317E+05
8	2.070	8.100E-05	1.260E+05	3.286E-26	2.151E+05
9	1.400	5.240E-05	1.947E+05	7.510E-26	1.527E+05
10	0.950	3.620E-05	2.819E+05	1.602E-25	1.018E+05
11	0.950	1.300E-03	7.849E+03	4.461E-27	2.834E+03
12	0.640	8.640E-04	1.181E+04	9.963E-27	1.927E+03
13	0.440	6.050E-04	1.687E+04	2.070E-26	1.224E+03
14	0.310	4.070E-04	2.507E+04	4.366E-26	8.938E+02
15	0.210	2.840E-04	3.593E+04	9.237E-26	6.263E+02
16	0.144	1.910E-04	5.342E+04	2.003E-25	4.308E+02
17	0.098	1.300E-04	7.849E+04	4.324E-25	2.923E+02
18	0.068	9.260E-05	1.102E+05	8.749E-25	1.986E+02
19	0.045	6.170E-05	1.654E+05	1.984E-24	1.377E+02
20	0.031	4.320E-05	2.362E+05	4.114E-24	1.025E+02

CH	ENERGY	C-NFLX	C-EDENS	C-NDENS
1	31.300	9.130E+04	1.463E-01	4.675E-03
2	21.100	1.138E+05	1.498E-01	7.099E-03
3	14.300	1.108E+05	1.200E-01	8.395E-03
4	9.720	1.099E+05	9.817E-02	1.010E-02
5	6.610	1.074E+05	7.910E-02	1.197E-02
6	4.500	1.088E+05	6.610E-02	1.469E-02
7	3.050	1.088E+05	5.442E-02	1.784E-02
8	2.070	1.039E+05	4.284E-02	2.070E-02
9	1.400	1.091E+05	3.697E-02	2.641E-02
10	0.950	1.071E+05	2.991E-02	3.149E-02
11	0.950	2.983E+03	8.329E-04	8.768E-04
12	0.640	3.012E+03	6.903E-04	1.079E-03
13	0.440	2.783E+03	5.289E-04	1.202E-03
14	0.310	2.883E+03	4.599E-04	1.484E-03
15	0.210	2.982E+03	3.915E-04	1.864E-03
16	0.144	2.992E+03	3.253E-04	2.259E-03
17	0.098	2.983E+03	2.675E-04	2.730E-03
18	0.068	2.920E+03	2.182E-04	3.208E-03
19	0.045	3.060E+03	1.859E-04	4.132E-03
20	0.031	3.307E+03	1.668E-04	5.381E-03

SSJ/4 F10 ELECTRONS - CONVERSION CONSTANTS

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX
1	30.500	4.620E-04	2.209E+04	1.161E-34	6.534E+06
2	20.800	3.890E-04	2.623E+04	2.022E-34	4.501E+06
3	14.000	3.020E-04	3.379E+04	3.869E-34	2.696E+06
4	9.400	2.430E-04	4.199E+04	7.161E-34	1.500E+06
5	6.400	1.940E-04	5.260E+04	1.317E-33	8.416E+05
6	4.400	1.580E-04	6.458E+04	2.353E-33	4.859E+05
7	2.980	1.260E-04	8.098E+04	4.356E-33	2.860E+05
8	2.030	1.020E-04	1.000E+05	7.900E-33	1.625E+05
9	1.380	8.240E-05	1.238E+05	1.438E-32	9.228E+04
10	0.950	6.690E-05	1.525E+05	2.574E-32	5.289E+04
11	0.960	6.370E-05	1.602E+05	2.675E-32	5.613E+04
12	0.650	4.320E-05	2.362E+05	5.825E-32	3.992E+04
13	0.440	2.920E-05	3.495E+05	1.273E-31	2.691E+04
14	0.300	1.990E-05	5.128E+05	2.740E-31	1.800E+04
15	0.206	1.370E-05	7.448E+05	5.796E-31	1.227E+04
16	0.140	9.300E-06	1.097E+06	1.256E-30	8.449E+03
17	0.096	6.370E-06	1.602E+06	2.675E-30	5.690E+03
18	0.066	4.380E-06	2.330E+06	5.658E-30	3.844E+03
19	0.046	3.020E-06	3.379E+06	1.177E-29	2.720E+03
20	0.031	2.060E-06	4.953E+06	2.561E-29	2.303E+03

CH	ENERGY	C-NFLX	C-EDENS	C-NDENS
1	30.500	2.142E+05	7.919E-03	2.596E-04
2	20.800	2.164E+05	6.606E-03	3.176E-04
3	14.000	1.926E+05	4.823E-03	3.445E-04
4	9.400	1.596E+05	3.274E-03	3.483E-04
5	6.400	1.315E+05	2.227E-03	3.479E-04
6	4.400	1.104E+05	1.550E-03	3.524E-04
7	2.980	9.597E+04	1.109E-03	3.721E-04
8	2.030	8.003E+04	7.632E-04	3.760E-04
9	1.380	6.687E+04	5.258E-04	3.810E-04
10	0.950	5.567E+04	3.632E-04	3.823E-04
11	0.960	5.847E+04	3.834E-04	3.994E-04
12	0.650	6.141E+04	3.314E-04	5.098E-04
13	0.440	6.115E+04	2.715E-04	6.171E-04
14	0.300	5.999E+04	2.199E-04	7.331E-04
15	0.206	5.959E+04	1.810E-04	8.787E-04
16	0.140	6.035E+04	1.511E-04	1.079E-03
17	0.096	5.927E+04	1.229E-04	1.280E-03
18	0.066	5.824E+04	1.001E-04	1.517E-03
19	0.046	5.913E+04	8.488E-05	1.845E-03
20	0.031	7.430E+04	8.756E-05	2.824E-03

SSJ/4 F10 IONS - CONVERSION CONSTANTS

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX
1	30.500	5.670E-04	1.800E+04	3.186E-28	5.324E+06
2	20.800	3.870E-04	2.637E+04	6.844E-28	4.525E+06
3	14.000	2.600E-04	3.925E+04	1.514E-27	3.132E+06
4	9.400	1.750E-04	5.831E+04	3.349E-27	2.083E+06
5	6.400	1.190E-04	8.575E+04	7.234E-27	1.372E+06
6	4.400	8.180E-05	1.247E+05	1.531E-26	9.386E+05
7	2.980	5.540E-05	1.842E+05	3.337E-26	6.504E+05
8	2.030	3.780E-05	2.699E+05	7.180E-26	4.384E+05
9	1.380	2.570E-05	3.970E+05	1.553E-25	2.959E+05
10	0.950	1.770E-05	5.765E+05	3.276E-25	1.999E+05
11	0.960	5.010E-04	2.037E+04	1.145E-26	7.137E+03
12	0.650	3.390E-04	3.010E+04	2.500E-26	5.087E+03
13	0.440	2.300E-04	4.437E+04	5.444E-26	3.416E+03
14	0.300	1.570E-04	6.499E+04	1.170E-25	2.281E+03
15	0.206	1.080E-04	9.448E+04	2.476E-25	1.557E+03
16	0.140	7.310E-05	1.396E+05	5.383E-25	1.075E+03
17	0.096	5.010E-05	2.037E+05	1.145E-24	7.235E+02
18	0.066	3.450E-05	2.958E+05	2.419E-24	4.880E+02
19	0.046	2.380E-05	4.287E+05	5.032E-24	3.451E+02
20	0.031	1.620E-05	6.299E+05	1.097E-23	2.929E+02

CH	ENERGY	C-NFLX	C-EDENS	C-NDENS
1	30.500	1.746E+05	2.762E-01	9.056E-03
2	20.800	2.175E+05	2.842E-01	1.367E-02
3	14.000	2.237E+05	2.398E-01	1.713E-02
4	9.400	2.216E+05	1.946E-01	2.071E-02
5	6.400	2.144E+05	1.554E-01	2.428E-02
6	4.400	2.133E+05	1.282E-01	2.914E-02
7	2.980	2.183E+05	1.079E-01	3.622E-02
8	2.030	2.160E+05	8.815E-02	4.343E-02
9	1.380	2.144E+05	7.216E-02	5.229E-02
10	0.950	2.104E+05	5.876E-02	6.185E-02
11	0.960	7.434E+03	2.087E-03	2.174E-03
12	0.650	7.826E+03	1.808E-03	2.781E-03
13	0.440	7.764E+03	1.475E-03	3.353E-03
14	0.300	7.604E+03	1.193E-03	3.978E-03
15	0.206	7.559E+03	9.829E-04	4.771E-03
16	0.140	7.677E+03	8.230E-04	5.879E-03
17	0.096	7.536E+03	6.690E-04	6.968E-03
18	0.066	7.394E+03	5.442E-04	8.246E-03
19	0.046	7.503E+03	4.610E-04	1.002E-02
20	0.031	9.448E+03	4.766E-04	1.537E-02

SSJ/4 F11 ELECTRONS - CONVERSION CONSTANTS

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX
1	29.500	6.310E-04	1.617E+04	8.787E-35	4.293E+06
2	20.500	5.440E-04	1.876E+04	1.467E-34	2.980E+06
3	14.000	4.280E-04	2.384E+04	2.730E-34	1.836E+06
4	9.500	3.490E-04	2.924E+04	4.934E-34	1.042E+06
5	6.500	2.780E-04	3.671E+04	9.052E-34	6.048E+05
6	4.430	2.260E-04	4.515E+04	1.634E-33	3.470E+05
7	3.030	1.820E-04	5.607E+04	2.966E-33	1.996E+05
8	2.080	1.490E-04	6.848E+04	5.278E-33	1.140E+05
9	1.430	1.210E-04	8.433E+04	9.453E-33	6.814E+04
10	0.950	9.500E-05	1.074E+05	1.812E-32	3.878E+04
11	0.960	1.010E-04	1.010E+05	1.687E-32	3.686E+04
12	0.670	6.850E-05	1.490E+05	3.564E-32	2.495E+04
13	0.460	4.710E-05	2.166E+05	7.550E-32	1.744E+04
14	0.320	3.100E-05	3.292E+05	1.649E-31	1.275E+04
15	0.218	2.090E-05	4.882E+05	3.590E-31	9.047E+03
16	0.150	1.430E-05	7.136E+05	7.626E-31	6.262E+03
17	0.101	9.630E-06	1.060E+06	1.682E-30	4.227E+03
18	0.071	6.630E-06	1.539E+06	3.475E-30	2.841E+03
19	0.049	4.490E-06	2.273E+06	7.435E-30	2.060E+03
20	0.034	3.000E-06	3.401E+06	1.604E-29	1.735E+03

CH	ENERGY	C-NFLX	C-EDENS	C-NDENS
1	29.500	1.455E+05	5.291E-03	1.793E-04
2	20.500	1.454E+05	4.405E-03	2.149E-04
3	14.000	1.311E+05	3.284E-03	2.346E-04
4	9.500	1.096E+05	2.262E-03	2.381E-04
5	6.500	9.305E+04	1.588E-03	2.443E-04
6	4.430	7.834E+04	1.104E-03	2.491E-04
7	3.030	6.588E+04	7.675E-04	2.533E-04
8	2.080	5.479E+04	5.288E-04	2.543E-04
9	1.430	4.765E+04	3.814E-04	2.667E-04
10	0.950	4.082E+04	2.663E-04	2.803E-04
11	0.960	3.839E+04	2.518E-04	2.623E-04
12	0.670	3.724E+04	2.040E-04	3.045E-04
13	0.460	3.791E+04	1.721E-04	3.741E-04
14	0.320	3.983E+04	1.508E-04	4.712E-04
15	0.218	4.150E+04	1.297E-04	5.949E-04
16	0.150	4.174E+04	1.082E-04	7.214E-04
17	0.101	4.185E+04	8.903E-05	8.815E-04
18	0.071	4.002E+04	7.136E-05	1.005E-03
19	0.049	4.204E+04	6.229E-05	1.271E-03
20	0.034	5.102E+04	6.297E-05	1.852E-03

SJ/4 F11 IONS - CONVERSION CONSTANTS

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX
1	29.500	5.490E-04	1.859E+04	3.402E-28	4.935E+06
2	20.500	3.810E-04	2.678E+04	7.054E-28	4.255E+06
3	14.000	2.600E-04	3.925E+04	1.514E-27	3.022E+06
4	9.500	1.770E-04	5.765E+04	3.276E-27	2.054E+06
5	6.500	1.210E-04	8.433E+04	7.005E-27	1.390E+06
6	4.430	8.240E-05	1.238E+05	1.509E-26	9.518E+05
7	3.030	5.640E-05	1.809E+05	3.224E-26	6.441E+05
8	2.080	3.870E-05	2.637E+05	6.844E-26	4.387E+05
9	1.430	2.660E-05	3.836E+05	1.448E-25	3.099E+05
10	0.950	1.770E-05	5.765E+05	3.276E-25	2.163E+05
11	0.940	5.010E-04	2.037E+04	1.170E-26	7.562E+03
12	0.640	3.500E-04	2.915E+04	2.459E-26	4.665E+03
13	0.440	2.400E-04	4.252E+04	5.217E-26	3.274E+03
14	0.290	1.670E-04	6.110E+04	1.138E-25	2.171E+03
15	0.195	1.140E-04	8.951E+04	2.478E-25	1.361E+03
16	0.134	7.830E-05	1.303E+05	5.251E-25	9.168E+02
17	0.090	5.270E-05	1.936E+05	1.162E-24	6.273E+02
18	0.062	3.710E-05	2.750E+05	2.395E-24	4.093E+02
19	0.042	2.560E-05	3.986E+05	5.124E-24	2.846E+02
20	0.028	1.770E-05	5.765E+05	1.112E-23	2.260E+02

CH	ENERGY	C-NFLX	C-EDENS	C-NDENS
1	29.500	1.673E+05	2.603E-01	8.824E-03
2	20.500	2.076E+05	2.692E-01	1.313E-02
3	14.000	2.159E+05	2.314E-01	1.653E-02
4	9.500	2.162E+05	1.909E-01	2.010E-02
5	6.500	2.138E+05	1.562E-01	2.402E-02
6	4.430	2.149E+05	1.296E-01	2.925E-02
7	3.030	2.126E+05	1.060E-01	3.499E-02
8	2.080	2.109E+05	8.716E-02	4.190E-02
9	1.430	2.167E+05	7.426E-02	5.193E-02
10	0.950	2.277E+05	6.359E-02	6.694E-02
11	0.940	8.045E+03	2.235E-03	2.377E-03
12	0.640	7.289E+03	1.671E-03	2.610E-03
13	0.440	7.440E+03	1.414E-03	3.214E-03
14	0.290	7.485E+03	1.155E-03	3.982E-03
15	0.195	6.982E+03	8.833E-04	4.530E-03
16	0.134	6.842E+03	7.175E-04	5.355E-03
17	0.090	6.971E+03	5.991E-04	6.657E-03
18	0.062	6.601E+03	4.709E-04	7.595E-03
19	0.042	6.776E+03	3.979E-04	9.473E-03
20	0.028	8.071E+03	3.869E-04	1.382E-02

SSJ/4 F12 ELECTRONS - CONVERSION CONSTANTS

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX
1	30.241	4.140E-04	2.465E+04	1.307E-34	7.141E+06
2	20.661	3.470E-04	2.941E+04	2.282E-34	4.898E+06
3	14.117	2.900E-04	3.519E+04	3.995E-34	2.736E+06
4	9.645	2.420E-04	4.217E+04	7.008E-34	1.531E+06
5	6.590	2.030E-04	5.027E+04	1.223E-33	8.518E+05
6	4.502	1.690E-04	6.038E+04	2.150E-33	4.776E+05
7	3.076	1.420E-04	7.186E+04	3.745E-33	2.652E+05
8	2.102	1.180E-04	8.648E+04	6.595E-33	1.491E+05
9	1.436	9.900E-05	1.031E+05	1.151E-32	8.296E+04
10	0.981	8.280E-05	1.232E+05	2.014E-32	4.709E+04
11	0.978	7.300E-05	1.398E+05	2.291E-32	5.325E+04
12	0.657	4.910E-05	2.078E+05	5.071E-32	3.659E+04
13	0.442	3.300E-05	3.092E+05	1.121E-31	2.460E+04
14	0.297	2.220E-05	4.596E+05	2.481E-31	1.652E+04
15	0.200	1.490E-05	6.848E+05	5.489E-31	1.116E+04
16	0.134	1.000E-05	1.020E+06	1.221E-30	7.520E+03
17	0.090	6.730E-06	1.516E+06	2.701E-30	4.981E+03
18	0.061	4.530E-06	2.253E+06	5.919E-30	3.366E+03
19	0.041	3.040E-06	3.357E+06	1.312E-29	2.340E+03
20	0.027	2.040E-06	5.002E+06	2.970E-29	1.891E+03

CH	ENERGY	C-NFLX	C-EDENS	C-NDENS
1	30.241	2.361E+05	8.691E-03	2.874E-04
2	20.661	2.371E+05	7.212E-03	3.491E-04
3	14.117	1.938E+05	4.874E-03	3.452E-04
4	9.645	1.587E+05	3.299E-03	3.420E-04
5	6.590	1.293E+05	2.221E-03	3.370E-04
6	4.502	1.061E+05	1.507E-03	3.346E-04
7	3.076	8.623E+04	1.012E-03	3.291E-04
8	2.102	7.091E+04	6.881E-04	3.273E-04
9	1.436	5.777E+04	4.634E-04	3.227E-04
10	0.981	4.800E+04	3.182E-04	3.244E-04
11	0.978	5.445E+04	3.604E-04	3.685E-04
12	0.657	5.570E+04	3.022E-04	4.599E-04
13	0.442	5.566E+04	2.477E-04	5.603E-04
14	0.297	5.562E+04	2.029E-04	6.830E-04
15	0.200	5.581E+04	1.671E-04	8.353E-04
16	0.134	5.612E+04	1.375E-04	1.026E-03
17	0.090	5.534E+04	1.111E-04	1.235E-03
18	0.061	5.519E+04	9.123E-05	1.496E-03
19	0.041	5.706E+04	7.733E-05	1.886E-03
20	0.027	7.003E+04	7.701E-05	2.852E-03

SSJ/4 F12 IONS - CONVERSION CONSTANTS

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX
1	30.589	7.060E-04	1.445E+04	2.551E-28	4.291E+06
2	20.884	4.820E-04	2.117E+04	5.473E-28	3.610E+06
3	14.258	3.290E-04	3.102E+04	1.174E-27	2.465E+06
4	9.734	2.250E-04	4.535E+04	2.515E-27	1.680E+06
5	6.646	1.530E-04	6.669E+04	5.418E-27	1.152E+06
6	4.537	1.050E-04	9.718E+04	1.156E-26	7.822E+05
7	3.098	7.150E-05	1.427E+05	2.487E-26	5.354E+05
8	2.115	4.880E-05	2.091E+05	5.338E-26	3.657E+05
9	1.444	3.330E-05	3.064E+05	1.146E-25	2.498E+05
10	0.986	2.280E-05	4.475E+05	2.451E-25	1.717E+05
11	0.974	4.020E-04	2.538E+04	1.407E-26	9.617E+03
12	0.666	2.750E-04	3.711E+04	3.008E-26	6.401E+03
13	0.456	1.880E-04	5.428E+04	6.426E-26	4.381E+03
14	0.312	1.290E-04	7.910E+04	1.369E-25	2.986E+03
15	0.214	8.820E-05	1.157E+05	2.919E-25	2.055E+03
16	0.146	6.040E-05	1.689E+05	6.247E-25	1.406E+03
17	0.100	4.130E-05	2.471E+05	1.334E-24	9.636E+02
18	0.068	2.830E-05	3.606E+05	2.863E-24	6.497E+02
19	0.047	1.940E-05	5.260E+05	6.042E-24	4.450E+02
20	0.032	1.320E-05	7.730E+05	1.304E-23	3.711E+02

CH	ENERGY	C-NFLX	C-EDENS	C-NDENS
1	30.589	1.403E+05	2.223E-01	7.266E-03
2	20.884	1.729E+05	2.263E-01	1.084E-02
3	14.258	1.729E+05	1.871E-01	1.312E-02
4	9.734	1.726E+05	1.543E-01	1.585E-02
5	6.646	1.733E+05	1.280E-01	1.926E-02
6	4.537	1.724E+05	1.052E-01	2.319E-02
7	3.098	1.728E+05	8.715E-02	2.813E-02
8	2.115	1.729E+05	7.205E-02	3.407E-02
9	1.444	1.730E+05	5.955E-02	4.124E-02
10	0.986	1.741E+05	4.953E-02	5.023E-02
11	0.974	9.874E+03	2.792E-03	2.866E-03
12	0.666	9.610E+03	2.247E-03	3.374E-03
13	0.456	9.607E+03	1.859E-03	4.076E-03
14	0.312	9.571E+03	1.532E-03	4.909E-03
15	0.214	9.602E+03	1.273E-03	5.947E-03
16	0.146	9.630E+03	1.054E-03	7.220E-03
17	0.100	9.636E+03	8.730E-04	8.730E-03
18	0.068	9.555E+03	7.139E-04	1.050E-02
19	0.047	9.468E+03	5.881E-04	1.251E-02
20	0.032	1.160E+04	5.943E-04	1.857E-02

SSJ/4 F13 ELECTRONS - CONVERSION CONSTANTS

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX
1	31.332	4.560E-04	2.238E+04	1.145E-34	7.109E+06
2	21.193	3.620E-04	2.819E+04	2.132E-34	5.077E+06
3	14.335	2.870E-04	3.555E+04	3.976E-34	2.930E+06
4	9.696	2.280E-04	4.475E+04	7.399E-34	1.687E+06
5	6.558	1.810E-04	5.638E+04	1.378E-33	9.723E+05
6	4.436	1.440E-04	7.086E+04	2.561E-33	5.592E+05
7	3.000	1.140E-04	8.951E+04	4.783E-33	3.230E+05
8	2.030	9.080E-05	1.124E+05	8.874E-33	1.856E+05
9	1.373	7.210E-05	1.415E+05	1.652E-32	1.070E+05
10	0.929	5.720E-05	1.784E+05	3.078E-32	6.099E+04
11	0.935	5.190E-05	1.966E+05	3.371E-32	6.765E+04
12	0.637	3.540E-05	2.883E+05	7.254E-32	4.590E+04
13	0.435	2.410E-05	4.234E+05	1.560E-31	3.140E+04
14	0.296	1.640E-05	6.222E+05	3.370E-31	2.146E+04
15	0.202	1.120E-05	9.111E+05	7.230E-31	1.454E+04
16	0.138	7.640E-06	1.336E+06	1.551E-30	9.953E+03
17	0.094	5.210E-06	1.959E+06	3.340E-30	6.812E+03
18	0.064	3.550E-06	2.874E+06	7.199E-30	4.599E+03
19	0.044	2.420E-06	4.217E+06	1.536E-29	3.154E+03
20	0.030	1.650E-06	6.184E+06	3.304E-29	2.597E+03

CH	ENERGY	C-NFLX	C-EDENS	C-NDENS
1	31.332	2.269E+05	8.500E-03	2.713E-04
2	21.193	2.396E+05	7.381E-03	3.483E-04
3	14.335	2.044E+05	5.179E-03	3.613E-04
4	9.696	1.740E+05	3.627E-03	3.741E-04
5	6.558	1.483E+05	2.541E-03	3.875E-04
6	4.436	1.261E+05	1.777E-03	4.006E-04
7	3.000	1.077E+05	1.248E-03	4.161E-04
8	2.030	9.142E+04	8.718E-04	4.295E-04
9	1.373	7.791E+04	6.110E-04	4.450E-04
10	0.929	6.565E+04	4.235E-04	4.559E-04
11	0.935	7.235E+04	4.683E-04	5.008E-04
12	0.637	7.206E+04	3.849E-04	6.043E-04
13	0.435	7.219E+04	3.187E-04	7.326E-04
14	0.296	7.249E+04	2.640E-04	8.917E-04
15	0.202	7.198E+04	2.165E-04	1.072E-03
16	0.138	7.212E+04	1.793E-04	1.299E-03
17	0.094	7.247E+04	1.487E-04	1.582E-03
18	0.064	7.186E+04	1.217E-04	1.901E-03
19	0.044	7.168E+04	1.006E-04	2.287E-03
20	0.030	8.658E+04	1.004E-04	3.346E-03

SSJ/4 F13 IONS - CONVERSION CONSTANTS

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX
1	30.081	9.840E-04	1.037E+04	1.861E-28	2.988E+06
2	20.503	6.700E-04	1.523E+04	4.010E-28	2.515E+06
3	13.975	4.570E-04	2.233E+04	8.626E-28	1.713E+06
4	9.525	3.110E-04	3.281E+04	1.860E-27	1.169E+06
5	6.492	2.120E-04	4.813E+04	4.003E-27	7.968E+05
6	4.425	1.450E-04	7.037E+04	8.586E-27	5.412E+05
7	3.016	9.860E-05	1.035E+05	1.853E-26	3.697E+05
8	2.056	6.720E-05	1.518E+05	3.987E-26	2.521E+05
9	1.401	4.580E-05	2.228E+05	8.586E-26	1.718E+05
10	0.955	3.120E-05	3.271E+05	1.849E-25	1.153E+05
11	0.971	1.570E-04	6.499E+04	3.614E-26	2.329E+04
12	0.663	1.070E-04	9.537E+04	7.766E-26	1.638E+04
13	0.453	7.330E-05	1.392E+05	1.659E-25	1.113E+04
14	0.310	5.010E-05	2.037E+05	3.547E-25	7.608E+03
15	0.212	3.420E-05	2.984E+05	7.598E-25	5.218E+03
16	0.145	2.340E-05	4.361E+05	1.624E-24	3.573E+03
17	0.099	1.600E-05	6.378E+05	3.478E-24	2.431E+03
18	0.068	1.090E-05	9.362E+05	7.433E-24	1.687E+03
19	0.046	7.470E-06	1.366E+06	1.603E-23	1.131E+03
20	0.032	5.100E-06	2.001E+06	3.376E-23	8.964E+02

CH	ENERGY	C-NFLX	C-EDENS	C-NDENS
1	30.081	9.932E+04	1.561E-01	5.188E-03
2	20.503	1.226E+05	1.591E-01	7.760E-03
3	13.975	1.226E+05	1.313E-01	9.393E-03
4	9.525	1.228E+05	1.085E-01	1.140E-02
5	6.492	1.227E+05	8.960E-02	1.380E-02
6	4.425	1.223E+05	7.371E-02	1.666E-02
7	3.016	1.226E+05	6.099E-02	2.022E-02
8	2.056	1.226E+05	5.037E-02	2.450E-02
9	1.401	1.226E+05	4.159E-02	2.969E-02
10	0.955	1.207E+05	3.379E-02	3.538E-02
11	0.971	2.398E+04	6.771E-03	6.973E-03
12	0.663	2.470E+04	5.762E-03	8.691E-03
13	0.453	2.457E+04	4.738E-03	1.046E-02
14	0.310	2.454E+04	3.915E-03	1.263E-02
15	0.212	2.462E+04	3.247E-03	1.532E-02
16	0.145	2.464E+04	2.688E-03	1.854E-02
17	0.099	2.455E+04	2.213E-03	2.236E-02
18	0.068	2.481E+04	1.853E-03	2.726E-02
19	0.046	2.459E+04	1.511E-03	3.285E-02
20	0.032	2.801E+04	1.436E-03	4.486E-02